

Maneuver Design for Galileo Asteroid Flybys

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Introduction

After four years of space flight, the Galileo spacecraft is finally on a direct trajectory to its final destination, Jupiter. It has taken three planetary gravity assists to achieve the energy necessary for Galileo to reach Jupiter. The Venus-Earth-Earth gravity assist route is referred to as a VEEGA trajectory. Each gravity assist required precise spacecraft delivery to the proper aimpoint to propel Galileo on the desired path to the next encounter. Enroute to Jupiter, two opportunities were available for close flybys of main-belt asteroids. Successful encounters with the asteroids 951-Gaspra (October 29, 1991) and 243-Ida (August 28, 1993) were achieved. The maneuver design challenge has been to achieve the necessary flyby conditions in a propellant-optimal manner while accommodating both trajectory and spacecraft operating constraints including stringent planetary quarantine restrictions. This paper will address the trajectory correction maneuvers (TCMs) which enabled the successful completion of the circuitous VEEGA trajectory (Figure 1) while providing for the first ever encounters with main-belt asteroids.

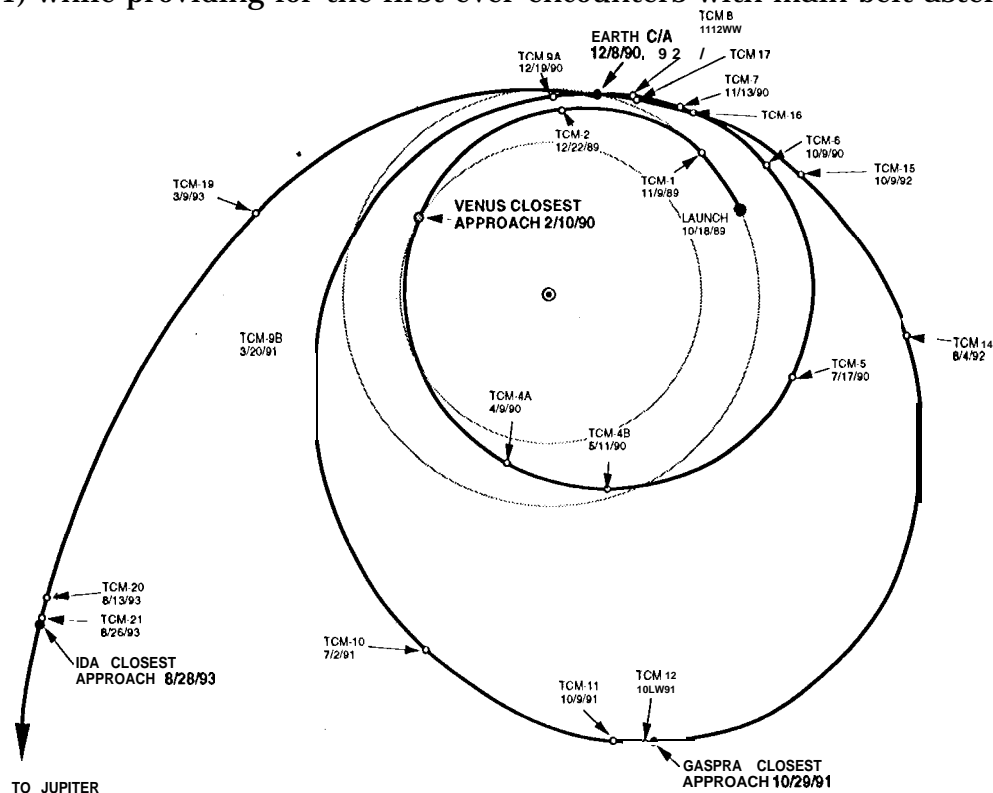


Figure 1: Galileo VEEGA Trajectory Correction Maneuvers

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Maneuver Design

Successful navigation of the Galileo spacecraft through two asteroid encounters was the result of a tremendous amount of work on the part of ground based observers, optical and radiometric orbit analysts, and trajectory and maneuver designers. The focus of this paper is on the design and results of trajectory correction maneuvers. This includes a discussion of the constraints placed upon each of the maneuver designs. Factored in each TCM design are constraints resulting from trajectory requirements, spacecraft and ground system capability, and spacecraft safety and consumables conservation. Included in the trajectory constraints are those requirements resulting from the plan to ensure safe passages through the Earth-Moon system with a Galileo spacecraft powered by radioisotope thermoelectric generators (or RTG's). A discussion of these constraints, as they apply to targeting for the first asteroid encounter, is included. A discussion of those maneuvers leading up to the second asteroid encounter is included as well as the first (and largest to date) maneuver which targeted directly to Jupiter.

References

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